

WHAT IS CLAIMED IS:

1. A method for forming a capacitor of a semiconductor device comprising the steps of:

5       forming an interlayer insulating film on a semiconductor substrate formed with a bit line,

          forming a contact plug in contact with the substrate within the interlayer insulating film,

          forming a storage electrode on the interlayer insulating  
10 film in such a manner that the storage electrode comes in contact with the contact plug,

          forming a dielectric film composed of a single composite film of  $Ta_2O_5(X)Y_2O_3(1-X)$  on the storage electrode according to ALD (Atomic Layer Deposition) technology,

15       depositing a diffusion barrier film on the dielectric film, and

          forming a plate electrode on the diffusion barrier film.

2. The method according to claim 1, wherein the step of  
20 forming the dielectric film comprises the sub-steps of:

          repetitively depositing a  $Ta_2O_5$  thin film and a  $Y_2O_3$  thin film in alternation to a predetermined thickness with ALD technology,

          performing low temperature annealing of the alternately

deposited thin films to convert the thin films into a single composite film,

performing  $\text{N}_2\text{O}$  plasma annealing of the converted single composite film to remove carbon and impurities contained  
5 within the single composite film, and

performing furnace annealing of the  $\text{N}_2\text{O}$  plasma annealed single composite film to crystallize the single composite film.

10 3. The method according to claim 2, wherein the  $\text{Ta}_2\text{O}_5$  thin film is deposited to a thickness of less than 10 Å by alternately injecting  $\text{Ta}(\text{OC}_2\text{H}_5)_5$  source gas and  $\text{H}_2\text{O}$  reaction gas into a reactor at a temperature of 250 to 350 °C according to ALD technology.

15 4. The method according to claim 3, wherein inert gas is injected at a period of time between that of injecting the  $\text{Ta}(\text{OC}_2\text{H}_5)_5$  source gas and that of injecting the  $\text{H}_2\text{O}$  reaction gas so as to leave no residue of the source and reaction  
20 gases.

5. The method according to claim 3, wherein each injection of the source gas, the inert gas and the reaction gas is performed for 0.1 to 10 seconds.

6. The method according to claim 2, wherein the  $Y_2O_3$  thin film is deposited to a thickness of less than 5 Å by alternately injecting yttrium source gas and  $H_2O$  reaction gas into a reactor at a temperature of 250 to 350 °C according to ALD technology.

7. The method according to claim 6, wherein inert gas is injected at a period of time between that of injecting the source gas and that of injecting the reaction gas so as to leave no residue of the source and reaction gases.

8. The method according to claim 6, wherein each injection of the source gas, the inert gas and the reaction gas is performed for 0.1 to 10 seconds.

9. The method according to claim 3, wherein in the deposition of the  $Ta_2O_5$  thin film and the  $Y_2O_3$  thin film,  $O_2$  or  $N_2O$  gas is injected as the reaction gas in place of  $H_2O$ .

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10. The method according to claim 4, wherein any one selected from the group consisting of  $N_2$ , Ar or He is injected as the inert gas.

11. The method according to claim 2, wherein the  $\text{Ta}_2\text{O}_5$  thin film and the  $\text{Y}_2\text{O}_3$  thin film are repetitively deposited in alternation up to an overall thickness of 100 to 200 Å.

5        12. The method according to claim 2, wherein the deposition ratio between the  $\text{Ta}_2\text{O}_5$  thin film and the  $\text{Y}_2\text{O}_3$  thin film is  $X:(1-X)$ .

13. The method according to claim 2, wherein the low  
10 temperature annealing is performed at a temperature of 400 to 550 °C.

14. The method according to claim 2, wherein the  $\text{N}_2\text{O}$  plasma annealing is carried out in a rapid thermal annealing  
15 mode in which annealing temperature is 300 to 400 °C, annealing time is 60 to 180 seconds and  $\text{N}_2\text{O}$  gas flow rate is 10 to 100 sccm.

15. The method according to claim 2, wherein the furnace  
20 annealing is performed at a temperature of 600 to 850 °C for 5 to 60 minutes while  $\text{N}_2$ ,  $\text{O}_2$  or  $\text{N}_2\text{O}$  gas flowing in a furnace.

16. The method according to claim 1, wherein the

diffusion barrier film is a TiN film.